United States
Department of
Agriculture

Forest
Service

Forest
Products
Laboratory

Dividends From Wood Research

Recent Publications
July–December 1994

Explanation and Instructions

"Dividends From Wood Research" is a semiannual listing of recent publications resulting from wood utilization research at the Forest Products Laboratory (FPL). These publications are produced to encourage and facilitate application of Forest Service research. This issue lists publications received from the printer between July 1 and December 31, 1994.

Each publication listed in this brochure is available through at least one of the following sources.

Available from FPL (indicated by an order number before the title of the publication): Quantities limited. Circle the order number on the blank at the end of the brochure and mail or FAX the blank to FPL.

Available through sales outlets (indicated by the name of theoutlet and, when available, price information): Major sales outlets are the Superintendent of Documents, the National Technical Information Service (NTIS), and various private publishers. Order directly from the outlet.

Available through libraries: Research publications are available through many public and university libraries in the United States and elsewhere. U.S. Government publications are also available through many Government Depository Libraries. Check with a major library near you to determine availability.

List of Categories

Publications are listed in this brochure within the following general categories.

- Biodeterioration and Protection
- Engineering Properties and Design Criteria
- Fiber and Particle Products
- Fire Safety
- Microbial and Biochemical Technology
- Mycology
- Processing of Wood Products
- Pulp, Paper, and Packaging
- Tropical Wood Utilization
- Wood Bonding Systems

Biodeterioration and Protection

1. Fungal Decay Resistance of Wood Impregnated With Para-Halophenyl Para-Tolyl Sulfonamides

Chen, G.C.
1994. Wood Sci. Technol. 28: 365–370

The purpose of this study was to investigate the influence of halophenyl groups of sulfonamides on fungitoxicity and water leachability of treated wood. The chemicals tested were para-fluorophenyl, para-chlorophenyl, para-bromophenyl, and para-iodophenyl para-tolyl sulfonamaides.

2. Dyed Particle Capture Immunoassay for Detection of Incipient Brown-Rot Decay

Clausen, Carol A.
1994. J. Immunoassay. 15(3): 305–316.

In this paper, an immunological method for detecting incipient fungal decay in wood is described.

3. Comparison of Laboratory and Field Methods to Evaluate Durability of Preservative-Treated Shakes

De Groot, Rodney C.
1994. Wood Fiber Sci. 26(3): 306–314.

The objective of this study was to illustrate the relative merits of three different methods that evaluate the durability of treated wood shakes. This study was part of a larger investigation on treated wood shakes that were manufactured from several species of trees in the western United States.

4. Treatability of Western Softwood and Red Alder Shakes

De Groot, Rodney C.
1994. Forest Prod. J. 44(7/8): 34–43.

The objective of this study was to describe the treatability of shakes manufactured from western softwood and red alder when pressure treated with different formulations of traditional and potential preservatives. The durability of treated shakes is being examined in corollary laboratory tests and field trials.

5. Decay Resistance in Conifer Seed Cones: Role of Resin Acids as Inhibitors of Decomposition by White-Rot Fungi

Eberhardt, Thomas L.; Han, James S.; Micales, Jessie A.; Young, Raymond A.
1994 Holzforschung. 48(4): 278–284.

To explore the possible role that resin acids may fulfill in decay resistance exhibited by conifer seed cones, this study investigated the resin acid composition from various sources of seed cones. Comparisons were made with the leaves, bark, and wood. Specific resin acids of the abietane and pimarane types were then selected to determine their ability to inhibit the decay of a woody substrate.

6. Weathering Performance of Finished Aspen Siding

Feist, William C.
1994. Forest Prod. J. 44(6): 15–23.

The primary objective of this study was to obtain information on the outdoor weathering performance and durability of different finishing systems on quaking aspen (*Populus tremuloides*). The finishes included were both commercially available and laboratory prepared. The effects of primer/finish substrate interactions were emphasized.

7. Comparative Weathering Tests of North American and European Exterior Wood Finishes

Kropf, Francois W., Sell, Jürgen, Feist, William C.
1994. Forest Prod. J. 44(10): 33–41.

With the goal of comparing the performance of exterior paints on weather-exposed wood surfaces in the United States and western Europe, a number of commercially available coating systems were applied to various wood surfaces and exposed on test fences in Madison, Wisconsin, and in northern Switzerland near Zurich for 5 years. This report summarizes the results of the performance and durability tests of the different coating systems.

8. Remediation of Pentachlorophenol- and Creosote-Contaminated Soils Using Wood-Degrading Fungi

Lamar, Richard T.; Kirk, T. Kent
1994. The International Research Group on Wood Preservation, Section 5, Environmental Aspects. Document IRG/WP 94–50021. 9 p.

During the past decade, a significant body of evidence demonstrated that fungi, in particular white-rot fungi, have the ability to degrade a wide range of hazardous organic compounds (xeno-biotics) and might be useful for treatment of materials contaminated with these compounds. Research has focused on the development of a soil remediation technology that is based on the xenobiotic-degrading abilities of these fungi. This work demonstrated that the technology is useful for remediation of pentachlorophenol-contaminated soils and may be useful for creosote-contaminated soils. In this presentation, the fungi and its xenobiotic-degrading abilities are described. A summary of applications of this technology to remediation of PCP and creosote-contaminated sites and a discussion of technological developments necessary for commercial-ization of the technology are given.

9. Life Cycle Analysis: Assessing Environmental Impact

LeVan, Susan L.
1994. Prepared for 25th annual meeting of the International Research Group on Wood Preservation; 1994 May 29–June 3; Bali, Indonesia. Section 5, Environmental Aspects. Document IRG/WP 94–50034. 12 p.

Life cycle assessment has received both positive and negative feedback on its utility as a process to evaluate environmental impact. This paper provides a brief history and overview of life cycle assessment, illustrating how it has been used and misused, listing its benefits and limitations, and outlining its possible applications to the wood preservation industry. Life cycle assessment provides an opportunity to quantify some environmental impacts of various wood preservation techniques and treatments; however, the process must be appropriately applied to gain the full benefit.

10. Epichlorohydrin Coupling Reactions With Wood: Part 1. Reaction With Biologically Active Alcohols

Rowell, R.M.; Chen, G.C.
1994. Wood Sci. Technol. 28: 361–376.

The purpose of this research was to develop a simple procedure for synthesizing glycidyl ethers. In future research, these glycidyl ethers will be reacted with wood and their toxicity to wood-destroying fungi in the bonded form will be determined. The procedure was developed using pentachlorophenol and then expanded to include other potential biocide alcohols such as 3,5-dimethyl phenol and 2-naphthol.

11. Effect of Preweathering, Surface Roughness, and Wood Species on the Performance of Paint and Stains

Williams, R. Sam; Feist, William C.
1994. J. Coatings Tech. 66(828): 109–121.

This study compares the paint bond strength previously reported for several other species with the paint servicelife on these species. Species included in this report are primarily dense softwoods, such as Southern Pine, and hardwoods, such as yellow-poplar and sweetgum. The effect of preweathering of dense wood species on subsequent finish performance has not previously been reported. The performance of roughsawn and smooth Southern Pine plywood is also compared.

12. Finishing Wood Decks

Williams R. Sam; Feist, William C.
1993. Wood Design Focus. 4(3): 1720.

Wood decks have become an important part of residential construction in recent years. However, there is considerable confusion regarding how these structures should be protected with finish. This paper summarizes the types, application techniques, and expected service lives of various finishes on both preservative treated and untreated lumber. Recommendations are made on the basis of decades of research on various wood species using a wide variety of finishes.

Engineering Properties and Design Criteria

13. Norwegian Bending Tests With Glued Laminated Beams—Comparative Calculations With the "Karlsruhe Calculation Model"

Aasheim, E.; Colling, F.; Ehlbeck, J.; Falk, R.H.; Görlacher, R.; Solli, K
1994. In: Proceedings of 26th meeting; International council for building research studies and documentation working commission W18–Timber structures; 1993 August; Athens, GA. CIB–W18. 10 p.

The investigations described in this paper were performed to estimate and predict the bending strength of glulam test beams using the "Karlsruhe calculation model." Test results (bending strength and modulus of elasticity) obtained in Oslo were unknown before finalizing the calculations and publishing the results.

14. Investigation of Laminating Effects in Glued-Laminated Timber

Colling, Francois; Falk, Rober H.
1994. In: Proceedings of the 26th meeting; International council for building research studies and documentation working commission W 18–Timber structures; 1993 August; Athens, GA. CIB–W18. 13 p.

In this study, existing lamination and beam test results were analytically reviewed in an attempt to quantify the laminating effect for glued-laminated (glulam) timber. The laminating effect is defined as the increase in strength of lumber laminations when bonded in a glulam beam compared to strength when tested by standard test procedures. Fundamental concepts are presented to describe the laminating effect, estimates are made of the various physical factors that make up the effect, and a relationship is presented to quantify the magnitude of the effect.

15. State of The Art Research-Stress Laminated Timber Bridge Decks Australia and North America

Crews, K.; Ritter, M.; GangaRao, H.
1994. In: PTEC 94 Timber shaping the future: Proceedings of Pacific timber engineering conference; 1994 July 11–15; Gold Coast, Australia. Fortitude Valley MAC, Queensland, Australia: Timber Research and Development and Advisory Council: 123–130. Vol. 2.

This paper presents an overview of the research and development work that has been undertaken in Australia since early 1990 and discusses

current state of the art development of stress laminated timber bridges in Australia and North America.

16. Housing Products From Recycled Wood Waste

Falk, R.
1994. In: PTEC 94 Timber shaping the future: Proceedings of Pacific timber engineering conference; 1994 July 11–15; Gold Coast, Australia. Fortitude Valley MAC, Queensland, Australia: Timber Research and Development and Advisory Council: 745–750. Vol. 2.

This paper describes the efforts at the Forest Products Laboratory that focus on the development of building products from recycled wood waste. Promising technologies, including dry- and wet-formed processing and wood/plastic and wood/cement composite manufacture, are discussed. Also covered are waste resource assessment and product performance evaluation and standards development, which are necessary to move recycled building products into widespread use.

17. Glued-Laminated Timber: Laminating Effects

Falk, R.; Colling, F.
1994. In: PTEC 94 Timber shaping the future: Proceedings of Pacific timber engineering conference; 1994 July 11–15; Gold Coast, Australia. Fortitude Valley MAC, Queensland, Australia: Timber Research and Development and Advisory Council: 618–625. Vol. 2.

In this paper, existing lamination and beam test results are analytically reviewed to quantify the laminating effect for European and North American glued-laminated (glulam) timber. Estimates are made of the magnitude of the laminating effect, and relationships are presented to describe its character based on an evaluation of beam and lamination test data.

18. Performance Level 1 Bridge Railings for Timber Decks

Faller, Ronald K.; Ritter, Michael A.; Holloway, James C.; Pfeifer, Brian G.; Rosson, Barry T.
1994 Transportation Research Record 1419.

The objective of this research project was to develop bridge-railing systems for timber bridge decks while addressing concerns such as aesthetics and economy. The USDA Forest Service, Forest Products Laboratory, in cooperation with the Midwest Roadside Safety Facility, undertook the task of developing three bridge railings—two glulam timber bridge-railing systems and one steel bridge-railing system—that would be compatible with the existing types of longitudinal timber bridge decks.

19. Effect of Ambient Temperatures on the Flexural Properties of Lumber

Green, D.; Evans, J.
1994. In: PTEC 94 Timber shaping the future: Proceedings of Pacific timber engineering conference; 1994 July 11–15; Gold Coast, Australia. Fortitude Valley MAC, Queensland, Australia: Timber Research and Development and Advisory Council: 190–197. Vol. 2.

This paper reports initial results on the effect of prolonged heating at 150°F (66°C) and 75% relative humidity (11% moisture content) on permanent changes in the flexural strength and stiffness of 2- by 4-in. (38- by 89-mm) lumber.

20. Moisture Content and the Properties of Clear Southern Pine

Green, D.W.; Kretschmann, D.E.
1994. USDA Forest Serv. Res. Pap. FPL–RP–531. 28 p.

The objective of this study was to establish a database for the mechanical properties of clear Southern Pine stressed in tension and compression parallel and perpendicular to grain, shear parallel to grain, three-point bending, and mode I (opening) and mode II (forward shear) stress intensity factors K_{IcTL} and K_{IIcTL}. The effects of moisture content on Poisson's ratios in the longitudinal-radial and longitudinal-tangential plane were also determined.

21. Production of Hardwood Machine Stress Rated Lumber

Green, David W.; Ross, Robert J.; McDonald, Kent A.
1994. In: Proceedings of 9th International symposium on nondestructive testing of wood; 1993 September 22–24; Madison, WI. Madison, WI: Forest Products Society: 141–150.

The objectives of this project were to train quality supervisors of the Northeastern Lumber Manufacturer's Association in the mechanical grading process, use MSR lumber produced from a hardwood species to construct a timber bridge, demonstrate the production of MSR lumber in a small mill, and learn the potentials and problems of smaller mills trying to use the MSR process.

22. Mechanical Properties of Dahurian Larch

Gupta, R.; Green, D.
1994. In: PTEC 94 Timber shaping the future: Proceedings of Pacific timber engineering conference; 1994 July 11–15; Gold Coast, Australia. Fortitude Valley MAC, Queensland, Australia: Timber Research Development and Advisory Council: 148–155. Vol. 2

There is growing interest in importing wood for structural lumber, thus interest in developing standardized methods of sampling and testing wood from foreign sources that will be acceptable and reliable in the American Standard grade marking system. This paper explains how basic strength values of an unfamiliar foreign species, Dahurian Larch from the Russian Far East, were determined. Preliminary results show that the strength values of Dahurian Larch are similar to many U.S. species.

23. Simulation Analysis of Norwegian Spruce Glued-Laminated Timber

Hernandez, Roland; Falk, Robert H.

1994. In: Proceedings of the 26th meeting; International council for building research studies and documentation working commission W 18–Timber structures; 1993 August; Athens, GA. CIB–W18. 16 p.

A computer analysis model, referred to as PROLAM, was used to simulate the performance of glued-laminated (glulam) timber beams manufactured from Norwegian spruce lumber. Specific objectives of this paper were to compare actual and simulated performance of glulam beams made from Norwegian spruce laminating stock and conduct sensitivity analyses to observe the effects of varying manufacturing parameters.

24. Fibre Stresses for Glued-Laminated Timber Utility Structures

Hernandez, R.; Moody, R.; Falk, R.
1994. In: PTEC 94 Timber shaping the future: Proceedings of Pacific timber engineering conference; 1994 July 11–15; Gold Coast, Australia. Fortitude Valley MAC, Queensland, Australia: Timber Research Development and Advisory Council: 639–647. Vol. 2.

The objective of this research was to develop a relationship for determining fiber stress values for glulam timber to be published in ANSI 05.2. These fiber stress values should have a basis similar to that used for comparable timber in ANSI 05.1 for round poles to provide equal reliability.

25. Strength Properties of Low Moisture Content Southern Pine

Kretschmann, D.; Green, D.
1994. In: PTEC 94 Timber shaping the future: Proceedings of Pacific timber engineering conference; 1994 July 11–15; Gold Coast, Australia. Fortitude Valley MAC, Queensland, Australia: Timber Research Development and Advisory Council: 731–739. Vol. 2

Contemporary engineering design practices in the United States require information on the strength of lumber for moisture content as low as 4 percent. Efficient design of experimental studies on lumber properties at low moisture content levels requires a better understanding of the basic mechanisms controlling moisture-property relationships. The study

reported here was conducted on the effect of moisture content on strength and stiffness in tension and compression parallel and perpendicular to grain and centerpoint bending.

26. Timber Bridges—A Rebirth

Moody, Russ
1994. Woodland Manage. 15(4): 18–20.

This paper is the second in a series of two articles on timber bridges. The U.S. Congress funded the Timber Bridge Initiative that began in fiscal year 1989. The ultimate objective of the research segment of this initiative is to develop accepted technology for improving the design and economics of timber bridges. Wisconsin received grants for four bridges during the first 5 years of this initiative and three have been built. This paper gives a brief description of two of these bridges.

27. Crashworthy Bridge Railing for Longitudinal Wood Decks

Ritter, M.
1994. In: PTEC 94 Timber shaping the future: Proceedings, Pacific timber engineering conference; 1994 July 11–15, Gold Coast, Australia. Fortitude Valley MAC, Queensland, Australia: Timber Research Development and Advisory Council.
2: 298–307.

To meet the need for crashworthy railing for wood bridges, the USDA Forest Service, Forest Products Laboratory, in cooperation with the Midwest Roadside Safety Facility of the University of Nebraska at Lincoln, the Federal Highway Administration and the wood products industry initiated a program to develop crash-tested bridge rails for longitudinal wood decks. The program objectives were to develop a total of five crashworthy rails: three to meet AASHTO PL–1 and two to meet AASHTO PL–2.

28. LRFD Provisions for Wood Bridges

Ritter, Michael A.; Norwak, Andrzej S.
1994. In: Baker, N.C.; Goodno, B.J., eds. Structures Congress 12: Proceedings of structures congress '94; 1994 April 2–28; Atlanta, GA. New York: American Society of Civil Engineers: 549–554. Vol. 1.

This paper briefly summarizes selected provisions of the new AASHTO LRFD specification as they relate to the design of wood bridges. These provisions include topics related to general design features, loads and load distribution, and wood design.

29. Development and Evaluation of the Teal River Stress-Laminated Glulam Bridge

Ritter, Michael A.; Wacker, James P.; Stanfill–McMillan, Kim; Kainz, James A.
1994. Transportation Research Record 1426: 27–35.

This paper describes the development, design, construction, and field performance of the Teal River bridge located in Sawyer County in northwestern Wisconsin. The bridge, built in 1989, is a two-lane, single-span, stress-laminated deck with a length of 9.91 m. The bridge design is the first known U.S. application that uses full-span structural glued-laminated (glulam) timber beams in a stress-laminated deck. In 1991, this bridge design was awarded first place in the National Timber Bridge Design Competition in the "Under 12-m Individual Span Vehicular Bridge" category.

30. Innovations in Glulam Timber Bridge Design

Ritter, Michael A.; Williamson, Thomas G.; Moody, Russell C.
1994. In: Baker, N.C.; Goodno, AB.J., eds. Structures Congress 12: Proceedings of structures congress '94; 1994 April 24–28; Atlanta, GA. New York: American Society of Civil Engineers: 1298–1303. Vol. 2.

This paper briefly describes the use of alternative species for glulam manufacture, applications employing glulam for stress-laminated decks and T and box sections, and the utilization of glulam in composite applications with other materials.

31. U.S. Timber Bridge Research

Ritter, M.; Moody, R.; Duwadi, S.
1994. In: PTEC 94 Timber shaping the future: Proceedings of Pacific timber engineering conference; 1994 July 11–15; Gold Coast, Australia. Fortitude Valley MAC, Queensland, Australia: Timber Research Development and Advisory Council:
148–155. Vol. 2

An extensive U.S. research program to further develop wood utilization in transportation structures is currently in progress as a joint effort of the USDA Forest Service, Forest Products Laboratory, and the U.S. Department of Transportation, Federal Highway Administration. This research is funded by U.S. legislation and involves cooperative research with universities, government agencies, and private industry. Within the program, research is divided into six areas: system development and design, lumber design properties, preservatives, alternate transportation system timber structures, inspection and rehabilitation, and technology and information transfer. This paper presents a brief summary of selected research program highlights within each of these areas.

32. National and Global Conditions Alter Structural Research and Management

Schaffer, E.L.
1994. In: PTEC 94 Timber shaping the future: Proceedings of Pacific timber engineering conference; 1994 July 11–15; Gold Coast, Australia. Fortitude Valley MAC, Queensland, Australia: Timber Research Development and Advisory Council:
751–753. Vol. 2.

This paper explains how research emphases and National focuses are affecting change in timber engineering and forest products research at the Forest Products Laboratory (FPL). The report includes a brief discussion of how a variety of other constraints may also cause the organization, staff, and future operation of FPL to adapt to changing trends worldwide.

Efficient Use of Red Oak for Glue-Laminated Beams

Shedlauskas, J.P.; Manbeck, H.B.; Janowiak, J.; Blankenhorn, P.R.; Labosky, P.; Hernandez, R.; Moody, R.C.
1994. Presented at American Society of Agricultural Engineers Meeting; 1994 December 13–16; Atlanta, Ga. Paper No. 94–4575. 23 p.

Available from American Society of Agricultural Engineers, 2950 Niles Road, St. Joseph, MI 4908—9659. Cost ASAE member $5.50; nonmember: $7.00 per copy plus $3.50 shipping and handling.

The objectives of this research were to (1) develop a red oak glulam combination, using a high percentage of No. 2 grade material, with a 16.5 MPa bending design stress and a 12.4 GPa design stiffness; (2) determine if the volume effect model currently in use for softwoods, yellow poplar, and red maple can be applied to red oak glulam beams and generalized to all hardwoods; and (3) determine if ASTM D 3737 procedures satisfactorily predict the bending design stress and modulus of elasticity of a red oak glulam beam.

33. Establishing Allowable Design Values for Structural Lumber of Foreign Species for Use in the United States

Shelley, Bradley E.; Green, David W.
1994. In: The globalization of wood: supply, processes, and markets. Proceedings 7319. Proceedings of conference; 1993 November 1–3; Portland, OR. Madison, WI: Forest Products Society: 215–228.

The purpose of this paper was to present a summary of the current procedures used to establish design values for structural lumber in the United States with special emphasis on species of foreign origin.

34. Strength and Stiffness of Large-Gap Metal-Plate Wood Connections

Stahl, Douglas C.; Wolfe, Ronald W.; Cramer, Steven M.; McDonald, Dwight.
1994. USDA Forest Serv. Res. Pap. FPL–RP–535. 9 p.

This study was conducted to determine the feasibility of fabricating light-frame trusses using square-cut commodity webs. A simple test was developed to identify different plate types and provide design information on square-cut webs to determine their effect on load capacity of truss connections.

35. Performance of Steel, Concrete, Prestressed Concrete, and Timber Bridges

Stanfill–McMillan, Kim; Hatfield, Cherilyn A.
1994. In: Developments in short and medium span bridge engineering '94: Proceedings of 4th International conference on short and medium span bridges; 1994 August 8–11; Halifax, Nova Scotia, Canada. Montreal, P.Q., Canada: The Canadian Society of Civil Engineering: 341–354.

Comparisons of bridge performance based on historical data were investigated and are presented in this paper. Analysis on material usage, structural and functional adequacy, and longevity are included. Construction and performance trends revealed by the data will be useful to bridge designers and managers.

36. Within-Board Lumber Density Variations From Digital X-ray Images

Suryoatmono, S.; Cramer, S.; Shi, Y.; McDonald, Kent A.
1994. In: Proceedings of 9th International symposium on nondestructive testing of wood; 1993 September 22–24; Madison, WI. Madison, WI: Forest Products Society: 168–175.

In this study, the overall research objectives were to nondestructively measure mesostructure characteristics of boards, such as density variations, and to establish the link between mesostructure and structural performance.

37. Durability in Stress Laminated Timber Bridges

Taylor, R.; Ritter, M.
1994. In: PTEC 94 Timber shaping the future: Proceedings of Pacific timber engineering conference; 1994 July 11–15; Gold Coast, Australia. Fortitude Valley MAC, Queensland, Australia: Timber Research and Development Advisory Council: 686–694. Vol. 1.

This paper reviews the basis for some of the bridge design requirements. The designer can then better understand some of the key elements necessary to ensure a durable design.

38. Indoor Humidity and the Building Envelope

TenWolde, Anton
1994. In: Rose, William B.; TenWolde, A., eds. Bugs, mold rot II: Proceedings of workshop on control of humidity for health, artifacts, and buildings; 1993 November 16–17; Oak Ridge, TN. Washington, DC: National Institute of Building Sciences: 37–41.

This paper focuses on the relationship between the design and construction of the building envelope, the interior humidity conditions, and the potential for moisture problems on or inside the building envelope.

39. The Moisture Balance: Fundamentals

TenWolde, Anton
1994. In: Rose, William B.; TenWolde, A., eds. Bugs, mold rot II: Proceedings of workshop on control of humidity for health, artifacts, and buildings; 1993 November 16–17; Oak Ridge, TN. Washington, DC: National Institute of Building Sciences: 67–69.

This paper focuses on moisture removal from the building and the role of moisture storage in various materials inside a building.

40. Criteria for Humidity in the Building and the Building Envelope

TenWolde, Anton; Rose, William B.
1994. In: Rose, William B.; TenWolde, A., eds. Bugs, mold rot II: Proceedings of workshop on control of humidity for health, artifacts, and buildings; 1993 November 16–17; Oak Ridge, TN. Washington, DC: National Institute of Building Sciences: 63–65.

This paper presents some basic concepts and issues that should be considered when formulating humidity criteria. These issues are often related and involve human health and comfort, building use, surface moisture and humidity, and resistance of building materials to moisture.

41. Design and Field Performance of a Metal-Plate-Connected Wood Truss Bridge

Triche, Michael H.; Ritter, Michael A.; Lewis, Stuart L.; Wolfe, Ronald W.
1994. In: Baker, N.C.; Goodno, B.J., eds. Structures Congress 12: Proceedings of Structures Congress '94; 1994 April 24–28; Atlanta, GA. New York: American Society of Civil Engineers: 1310–1315. Vol. 2.

This paper describes an ongoing study on the design and performance attributes of an experimental wood-truss bridge. This is believed to be the first roadway bridge application of metal-plate-connected wood trusses.

42. Effects of Long-Term Elevated Temperature on CCA-Treated Southern Pine Lumber

Winandy, J.E.
1994. Forest Prod. J. 44(6): 49–55.

The objective of this study was to determine the influence of extended high-temperature exposure on the mechanical properties and chemical composition of CCA-treated Southern Pine lumber. Different treatment processing factors were evaluated to determine their relative effect on the rate of thermal degradation for CCA-treated lumber. The information obtained will be used to plan additional research to assess the need for an independent temperature modification factor for CCA-treated materials used in high temperature environments.

43. Material Selection and Preservative Treatments for Outdoor Wood Structures

Winandy, Jerrold E.; McDonald, Kent A.
1993. Wood Design Focus. 4(3): 8–13.

The long-term performance of wood in exterior exposure depends on material quality and decay resistance, either natural or that imposed by chemical treatment. The information presented here is intended to aid those who design and construct wood decks or similar outdoor structures.

44. Nailed Construction: A Comparison of 1986 and 1991 National Design Specification Methods

Winistorfer, S.G.
1994. ASAE Transactions. American Society of Agricultural Engineers. 37(2): 603–610.

The National Design Specification for Wood Construction, published by the American Forest and Paper Association, is the primary guide used in designing timber structures in the United States. This article compares the lateral and withdrawal nail design methods in the 1991 NDS to those in the 1986 NDS. A lateral nail design example is included for illustration.

45. Effect of Dynamic Loads on Lateral Strength of Nail Connections for the Manufactured/Modular Housing Industry

Winistorfer, Steve G.; Soltis, Lawrence A.
1993. In: Wind and seismic effects: Proceedings of 25th joint meeting of the U.S.–Japan panel on wind and seismic effects; 1993 May 17–20; Tsukuba, Japan. Tsukuba, Japan: Public Works Research Institute: 665–692.

The lateral resistance of timber connections depends not only on the properties of the fasteners and wood members used but on the filler materials that separate those wood members and the fabrication and in-service environments of the connection. This study attempted to determine the effects of dynamic forces on nailed joints with two types of filler materials separating wood members, in two different humidity environments, and with different types of construction practices.

46. Wind Resistant Design of Light-Frame Buildings

Wolfe, Ronald W.
1993. In: Wind and seismic effects: Proceedings of 25th joint meeting of the U.S.–Japan panel on wind and seismic effects; 1993 May 17–20; Tsukuba, Japan. Tsukuba, Japan: Public Works Research Institute: 615–634.

47. Wind Resistance of Conventional Light-Frame Buildings

Wolfe, Ronald W.; Riba, Ramon M.; Triche, Mike
1994. In: Hurricanes of 1992: Proceedings of a symposium organized by The American Society of Civil Engineers; 1993 December 1–3; Miami, FL. New York: American Society of Civil Engineers: Div. 1–Div. 11.

These two papers (#46 and #47) review the damage to light-frame structural assemblies observed following Hurricane Andrew's pass through southern Florida in August 1992, provide some assessment as to why the damage was so costly, and summarize recommendations of the light-frame construction industries regarding design and construction methods to minimize the effects of similar occurrences in the future.

Fiber and Particle Products

48. Migration of Metals Through Linerboard: An Exploratory Study

Bormett, David W.; Spenadel, Paula.
1993. Tappi J. 76(10): 19–25.

This study was designed to examine the potential for metal migration by subjecting a starch-coated linerboard to a constant moisture gradient and determining the metal content change near the noncoated surface.

49. Basic Mechanical Properties of Flakeboards From Ring-cut Flakes of Eastern Hardwoods

Carll, Charles G.
1994. Forest Prod. J. 44(9): 26–32.

The experimental work described in this paper was undertaken to provide data on mechanical properties of flakeboards made from less than high quality flakes of underutilized American hardwoods. Properties presented are those of consequence in core and intermediate layers of structural flakeboard.

50. Fungal Decay Resistance of Wood Reacted With Chlorosulfonyl Isocyanate or Epichlorohydrin

Chen, George C.
1994. Holzforschung. 48(3): 181–185.

Scientists are searching for chemical treatments that can cross-link with wood causing minimal damage to mechanical properties while improving decay resistance. The objectives of this study were to investigate the reactions between wood and chlorosulfonyl isocyanate or epichlorohydrin and determine fungal resistance of the treated wood.

51. Moisture Sorption and Swelling of Wood–Polymer Composites

Ellis, W. Dale
1994. Wood and Fiber Sci. 26(3): 333–341.

The objectives of this research were to (1) identify monomers that swell and penetrate the cell wall without the use of solvents, (2) measure the extent of swelling as a result of soaking in individual monomers, (3) polymerize the monomer in the wood, and (4) measure the volumetric swelling and moisture content of the wood–polymer composites at 90% relative humidity.

52. Meeting Society's Challenge: Value-Added Products From Recycled Materials

English, Brent
1992. In: Proceedings of the Pacific Rim bio-based composites symposium; 1992 November 9–13; Rotorua, New Zealand. FRI Bull. 177. Rotorua, New Zealand: New Zealand Forest Research Institute: 326–335.

This paper describes the potential for producing selected composites from waste wood, paper, and plastics. Discussed first is the availability of waste materials in the municipal solid waste stream and the desirability of developing ways to recycle these materials into useful, high-performance, value-added composites. Methods for making selected composites are then described, and discussion is offered on product properties and attributes. Finally, research and development needs are outlined that will maximize the benefits of using recovered waste materials for composite products.

Wood Recylcing: Challenges to the Chemical Industry

English, Brent
1994. In: Proceedings of the Chemical Management and Resources Association; 1994 October 5–7; New Orleans, La: 291–296.

Available from The Chemical Management & Resources Association, 60 Bay Street, Suite 702, Staten Island, NY 10301. Cost $35.

The forest products industry is looking seriously at recycled wood as a source of raw materials to make a variety of composite products. The plastic industry also has a growing awareness of the benefits of using wastepaper and wood fiber as a reinforcing filler in thermoplastics. Treated wood is difficult to recycle with currently available technologies. This paper is a discussion of these areas of challenges and opportunities for the chemical industry.

53. Paper Fiber/Low-Density Polyethylene Composites From Recycled Paper Mill Waste: Preliminary Results

English, Brent; Schneider, James P.
1994. In Proceedings of the 1994 TAPPI Recycling symposium; 1994 May 15–18; Boston, MA. Atlanta, GA: TAPPI Press: 119–125.

This report describes research on converting waste poly rejects into a composite using plastic processing techniques. Property data of the composite are reported, and future work and recommendations are outlined.

54. Lignocellulosic Composites

English, Brent; Youngquist, John A.; Krzysik, Andrzej M.
1994. In: Gilbert, Richard D., ed. Cellulosic polymers, blends and composites. New York: Hanser Publishers: 115–130. Chap. 6.

This chapter first briefly reviews various chemical treatments to wood and wood composites. Traditional veneer-, particle-, and fiber-based lignocellulosic composite materials and technology are discussed next. Then, forecasted improvements in existing technology are presented. Greater detail is then presented by reviewing developing opportunities for producing new types of value-added, thermoformable lignocellulosic composites using blends of different materials. Current research in this area is illustrated, and properties of selected materials are given.

Adhesive Curing and Bonding: Response to Real Time Conditions

Geimer, Robert L.; Christiansen, Alfred W.
1991. In: Hse, Chung–Yun, Tomita, Bunichiro; Branham, Susan J. Proceedings sponsored by the USDA Forest Service, Southern Forest Experiment Station, and the Japan Wood Research Society and cosponsored by the Forest Products Society, the Japan Plywood Technology Laboratory, the Japan Thermosetting Plastics Industry Association, and the University of

Tokyo; 1991 November 19–21; Seattle, Washington. Proceedings No. 4735. pp. 13–29.

Available from Forest Products Society, 2801 Marshall Court, Madison, WI 5370–2295. Cost $2 each with $5 minimum, plus 10 percent postage and handling.

This paper describes steam injection pressing and the internal board environments specific to the process. A general outline of a resin characterization program is given along with test results, indicating the potential of this technique to distinguish between resin types.

Carbon Dioxide Application for Rapid Production of Cement Particleboard

Geimer, Robert L.; Souza, Mario R.; Moslemi, Ali A.; Simatupang, Maruli, H.
1993. In: Moslemi, A.A., ed., Inorganic-Bonded Wood and Fiber Composite Materials, 1992. Vol. 3.

Available from Forest Products Society, 2801 Marshall Court, Madison, WI 53705–2295. Cost $2 each with $5 minimum, plus 10 percent postage and handling.

The objective in this study was to determine the effect of changes in fabrication and pressing variables for cement-bonded wood composites on composite properties immediately after pressing and following a 28-day curing in boards pressed using a carbon dioxide injection pressing technique.

Effect of Resin Variables on Properties of Steam-Press Cured Flakeboards

Hse, Chung–Yun; Geimer, Robert L.; Hsu, W. Ernest; Tang, R.C.
1991. In: Hse, Chung–Yun, Tomita, Bunichiro; Branham, Susan J. Proceedings sponsored by the USDA Forest Service, Southern Forest Experiment Station, and the Japan Wood Research Society and cosponsored by the Forest Products Society, the Japan Plywood Technology Laboratory, the Japan Thermosetting Plastics Industry Association, and the University of Tokyo; 1991 November 19–21; Seattle, Washington. Proceedings No. 4735. pp. 31–44.

Available from Forest Products Society, 2801 Marshall Court, Madison, WI 53705–2295. Cost $2 each with $5 minimum, plus 10 percent postage and handling.

The objective of this study was to compare the properties of steam injection pressed flakeboards made from either Southern Pine or white oak, using six different resin adhesives, with control boards pressed in a conventional fashion.

55. Opportunities for Value-Added Bio-Based Composites

Rowell, Roger M.
1992. In: Proceedings of the Pacific Rim-bio-based composites symposium; 1992 November 9–13; Rotorua, New Zealand. FRI Bull. 177. Rotorua, New Yealand: New Zealand Forest Research Institute: 244–252.

From the perspective of research, four basic concepts in considering value-added biobased composites are discussed in this paper. The first consideration is a concept of composite versus material; the second is the type of composite or material; the third is flat sheet versus shaped technologies; the fourth is market opportunities for composites or materials.

56. Property Enhanced Kenaf Fiber Composites

Rowell, Roger M.; Harrison, Sandra E.
1993. In: Proceedings of the 1993 International kenaf conference; 1993 March 3–5; Fresno, CA. Fresno, CA: International Kenaf Association: 129–136.

Results from this study show that fiberboards made from kenaf bast fiber are not as strong as boards made from hemlock fiber. Acetylation of kenaf fiber before board formation greatly reduced equilibrium moisture content, and rate and extent of thickness swelling; and fiberboards made from acetylated kenaf fiber produce a fiberboard with very smooth surfaces, which requires much less sanding, has a very high surface consolidation (much fewer fibers sticking out after pressing), and little color change compared to untreated fiber.

Time is Ripe for Structural Insulated Panels—60 Years of Research, Durability Testing Now Bearing Fruit for Builders

Sherwood, Gerald E.; Spelter, Henry
1994. Automated Builder. 31(10): 22–23.

Available from Automated Builder, 4371 Carpinteria Ave., Carpinteria, CA 93013. Single back copies are $6.

This article summarizes 60 years of research and testing on foam-care panels conducted by several generations of engineers at the Forest Products Laboratory.

57. Capacity, Production, and Manufacturing of Wood-Based Panels in North America

Spelter, Henry
1994. USDA Forest Serv. Gen. Tech. Rep. FPL–GTR–82. 17 p.

This report is an informational report about four wood-based panel industries: particleboard, oriented strandboard, medium density fiberboard, and Southern Pine plywood. Items highlighted are trends in manufacturing and new plant costs, industry manufacturing capacity, and location.

Literature Review on Use of Nonwood Plant Fibers for Building Materials and Panels

Youngquist, John A.; English, Brent; Scharmer, Roger C.; Chow, Poo; Shook, Steven R.
1994. USDA Forest Serv. Gen. Tech. Rep. FPL–GTR–80. 146 p.

Available from NTIS, 5285 Port Royal Road, Springfield, VA 22161. Cost $27 hardcopy, $12.50 microfiche, order #PB94207438. Phone 1–800–553–6847.

The research studies included in this review focus on the use of nonwood plant fibers for building materials and panels. Studies address (1) methods for efficiently producing building materials and panels from nonwood plant fibers; (2) treatments of fibers prior to board production; (3) process variables, such as press time and temperature, press pressure, and type of equipment; (4) mechanical and physical properties of products made from nonwood plant materials; (5) methods used to store nonwood plant materials; (6) use of nonwood plant fibers as stiffening agents in cementitious materials and as refractory fillers; and (7) cost-effectiveness of using nonwood plant materials.

Fire Safety

58. Time–Temperature Profile Across a Lumber Section Exposed to Pyrolytic Temperatures

Shrestha, D.; Cramer, S.; White, R.
1994. Fire Mater. 18: 211–220.

This paper presents a closed-form solution with empirical adjustments to predict the time–temperature profile across a lumber section when the exposure history of its surface is known. The formulation is based on the two-dimensional heat-conduction equation that includes the effects of moisture evaporation and pyrolysis of wood.

59. Fire Performance of Wood: Test Methods and Fire Retardant Treatments

Sweet, Mitchell S.
1993. In: Lewin, Menachem, ed. Recent advances in flame retardancy of polymeric materials. Proceedings of the 4th annual BCC conference on flame retardancy; 1993 May 18–20; Stamford, CT. Norwalk, CT: Business Communications Co., Inc.: 36–43.

This report describes the fire performance characteristics of wood and wood products, along with test methods for evaluating the fire properties of these materials. Wood treated with fire retardants may provide a code-approved alternative to noncombustible materials. Fire performance and problems associated with thermal degradation are discussed in terms of the mechanisms of fire retardancy.

60. Simulating Wall and Corner Fire Tests on Wood Products With the OSU Room Fire Model

Tran, Hao C.
1994. In: Fowell, Andrew, J., ed. Fire and flammability of furnishing and contents of buildings: Proceedings of symposium; 1992 December 2; Miami, FL. ATSM STP 1233. Philadelphia, PA: American Society for Testing and Materials: 153–168.

This work demonstrates the complexity of modeling wall and corner fires in a compartment. The model chosen is the Ohio State University room fire model. This model was designed to stimulate fire growth on walls in a compartment and therefore lends itself to direct comparison with standard room test results.

61. Improving the Fire Endurance of Wood Truss Systems

White, R.; Cramer, S.
1994. In: PTEC 94 Timber shaping the future: Proceedings of Pacific timber engineering conference; 1994 July 11–15; Gold Coast, Australia. Fortitude Valley MAC, Queensland, Australia: Timber Research and Development Advisory Council: 582–589. Vol. 1.

The objective of this research project was to investigate ways to improve the fire resistance of wood truss systems without improving the ceiling membranes. This report describes tests to identify the range of current performance of metal plate connectors and evaluate possible modification or protection of the plates to improve their fire endurance.

62. Serviceability Modelling of Fire-Retardant-Treated Plywood Roof Sheathing

Winandy, J.
1994. In: PTEC 94 Timber shaping the future: Proceedings of Pacific timber engineering conference; 1994 July 11–15; Gold Coast, Australia. Fortitude Valley MAC, Queensland, Australia: Timber Research and Development Advisory Council: 292–297. Vol. 2.

This paper outlines the overall approach for developing a predictive service-life model through the fire-retardant-treated plywood serviceability program. When combined, each study will contribute to the final methodology that will assess the current residual strength of fire-retardant material, predict the future temperature history of the material, and finally estimate the rate of future degradation of the material properties based on the predicted elevated temperature exposures.

Microbial and Biochemical Technology

63. Comparison of Corn Steep Liquor With Other Nutrients in the Fermentation of D-Xylose by *Pichia stipitis* 6054

Amartey, Samuel; Jeffries, Thomas W.
1994. Biotechnology Letters. 16(2): 211–214.

Results of this study show that a fermentation medium containing corn steep liquor as the sole source of nitrogen, vitamins, and other nutritional requirements compares favorably with several more complex media formulations for the fermentations of xylose to ethanol by *P. stipitis* CBS 6054.

64. Purification, Characterization, and Substrate Specificities of Multiple Xylanases From Streptomyces sp. Strain B-12-2

Elegir, Graziano; Szakacs, George; Jeffries, Thomas W.
1994. Appl. Environ. Microbiol. 60(7): 2609–2615.

This paper reports the purification and characterization of five endoxylanases from a highly xylanolytic organism, Streptomyces sp. strain B-12-2, and their action patterns. The enzymes can be divided into two broad groups on the basis of their molecular weights, isoelectric points, and substrate specificities; however, their action patterns—considered in total—appear to be distinct from one another.

65. Strain Selection, Taxonomy, and Genetics of Xylose-Fermenting Yeasts

Jeffries, T.W.; Kurtzman, C.P.
1994. Enzyme Microb. Technol. Vol. 16, November.

Xylose utilization is essential for the efficient conversion of lignocellulose to ethanol. The objective of this review is to trace the development of xylose fermenting yeast strains from their discovery in 1980.

66. Changes in the Molecular-Size Distribution of Insoluble Celluloses by the Action of Recombinant *Cellulomonas fimi* Cellulases

Kleman–Leyer, Karen M.; Gilkes, Neil R.; Miller, Robert C., Jr.; Kirk, T. Kent
1994. Biochem. J. 302: 463–469.

The purpose of the present study was to determine the effects of isolated endoglucanases CenA, CenB, CenD, and Cex on the molecular-size distribution of cotton cellulose, bacterial cellulose, and bacterial microcrystalline cellulose. The first description of the changes in the molecular-size distribution of insoluble cellulosic substrates by purified cellulases is reported.

67. Lipid Peroxidation by the Manganese Peroxidase of *Phanerochaete chrysosporium* is the Basis for Phenanthrene Oxidation by the Intact Fungus

Moen, Mark A.; Hammel, Kenneth E.
1994. Appl. Environ. Microbiol. 60(6): 1956–1961.

The ability of white-rot fungi to degrade polycyclic aromatic hydrocarbons (PAHs) stems in part from the action of ligninolytic enzymes on these hydrocarbons. However, some PAHs that are not lignin peroxidase substrates are nevertheless degraded by white-rot fungi. We recently reported that *P chrysosporium* cleaves one such PAH, phenanthrene, to 2,2'-diphenic acid (DPA) by an unknown mechanism. We now show that this reaction is a cooxidative consequence of lipid peroxidation by another ligninolytic fungal enzyme, manganese peroxidase.

68. Crystallinity in the Polypropylene/Cellulose System. II. Crystallization Kinetics

Quillin, Daniel T.; Yin, Mengping; Koutsky, James A.; Caulfield, Daniel F.
1994. J. Appl. Polym. Sci. 52: 605–615.

This study shows that factors such as surface treatment, cooling rate, intimacy of mixing, and filler content can play a significant role in the crystallization process of any filled thermoplastic. As a result, changes in the kinetics of crystallization will effect the structure and morphology of the crystalline phase and could result in measurable differences in the mechanical performance of the composite material.

Mycology

69. *Armillaria* Infection and Water Stress Influence Gas-Exchange Properties of Mediterranean Tress

Loreto, Francesco; Burdsall, Harold H., Jr.; Tirro', Alfio
1993. HoartScience 28(3): 222–224.

This study investigated whether (1) North American isolates of *A. mellea* and *A. ostoyae* affect gas-exchange characteristics and water potential of orchard trees typical of the Mediterranean area and (2) water stress associated with the Armillaria infection further modifies gas-exchange characteristics and water potential of plants tested.

70. Species Delimitation in North American Species of *Armillaria* as Measured by DNA Reassociation

Miller, Orson K., Jr.; Johnson, John L.; Burdsall, Harold H.; Flynn, Timothy.
1994 Mycol. Res. 98(9): 1005–1011.

In this study, the relatedness among biological species in *Armillaria* was explored using DNA reassociation experiments. Strains including nine of

the ten reproductively isolated North American biological species were used.

71. *Phanerochaete filamentosa–Corticium radicatum* Species Complex in North America

Nakasone, Karen K.; Bergman, Cindy R.; Burfdsall, Harold H., Jr.
1994. Sonderdrucke aus SYDOWIA–Band 46(1): 44–62.

This paper resolves the *Phanerochaeate filamentosa–Corticium radicatum* species complex and describes a new species, *Ceraceomyces americanus*. Basidioma and cultural descriptions of these phenotypically similar taxa are included.

72. Checklist and Host Index of Wood-Inhabiting Fungi of Alaska

Volk, Thomas J.; Burdsall, Harold H., Jr.; Reynolds, Keith
1994. Mycotaxon 12(1):L 1–46.

In this study of 754 collections of wood-inhabiting fungi from Alaska, 254 species of wood-inhabiting fungi are reported, mostly in the Corticiaceae *sensu lato* and Polyporaceae *sensu lato*. One hundred fifty-one of these are new records for Alaska, and nine are new records for North America. A host index to fungi collected is included. Also included is a list of fungi previously reported from Alaska not collected in this study. This survey provides a baseline study for fungi in old-growth forests of Alaska.

Processing of Wood Products

73. Wetting Agent and Ultrasonic Cavitation Effects on Drying Characteristics of Three U.S. Hardwoods

Chen, Peter Y.S.; Simpson, William T.
1994. Wood Fiber Sci. 26(3): 438–444.

This study evaluates the hypothesis that the combined effects of a wetting agent and ultrasonic cavitation will lower the bonding between wood and water, enhance the disruption and dissolution of extractives encrusted on pit membranes, and improve the permeability and subsequent drying characteristics of three U.S. hardwoods

74. Honeycomb and Surface Check Detection Using Ultrasonic Nondestructive Evaluation

Fuller, James J.; Ross, Robert J.; Dramm, John R.
1994. USDA Forest Serv. Res. Note FPL–RN–0261.

The objective of this study was to determine if speed of sound transmission perpendicular to the grain is sensitive to the presence of honeycomb and closed surface checks in red oak lumber.

75. Use of Green Moisture Content and Basic Specific Gravity to Group Tropical Woods for Kiln Drying

Hidayat, Syarif; Simpson, William T.
1994. USDA Forest Serv. Res. Note FPL–RN–0263. 39 p.

A previous study developed grouping criteria that used basic specific gravity and green moisture content as estimators of drying time. Results of this study showed that species whose estimated drying times fall within a reasonable range can be grouped together for kiln drying. The previous study applied the grouping to 650 tropical species. The purpose of the study reported here was to extend the grouping to additional tropical species, bringing the total to more than 1,300.

76. Derivation of Surface Emission Coefficient in Iosthermal Diffusion Analyses

Liu, Jen Y.
1994. In: Rudolph, V.; Keey, R.B., eds. Drying 94: Proceedings of 9th Internaional drying symposiium (IDS '94); 1994 August 1–4; Gold Coast, Australia: 141–148. Vol. A.

In this paper, mathematical equations for surface emission coefficient S in isothermal diffusion analyses of porous solids are derived. The equations are evaluated from either experimental sorption or desorption curves, which are also used to derive the diffusion coefficient D as a function of the concentration of diffusing substance C.

77. Diffusion Coefficient of Porous Solid Obtained From Isothermal Sorption Tests

Liu, Jen Y.
1994. USDA Forest Serv. Res. Pap. FPL–RP–533. 10 p.

In this study, a mathematical equation was derived to separate the diffusion coefficient and the surface emission coefficient in Newman's solution of the unsteady-state diffusion equation from an experimental sorption curve. Based on this derived equation, a theoretical expression for the diffusion coefficient was also derived.

Developing High-Value Blockboard Made of Alder and Other Pacific Northwest Hardwoods

Maloney, T.M.; Ross, R.J.; Lentz, M.T.; Allwine, R.
1993. WSU Project No.: 12D–3808–2809. Forest Service Project No. (Madison): FP92–1854. 81 p.

Available from T. M. Maloney, Washington State University, Wood Materials and Engineering Laboratory, College of Engineering an Architecture, Pullman, Washington. No Charge.

This report covers the project on blockboard. The finished blockboard is aesthetically pleasing, made from solid wood, has high strength properties, is dimensionally stable, light in weight, holds screws well, and can be used in a wide array of designs.

78. Evaluation of Timber Bridges Using Stress Wave Technology

Pellerin, R.; Ross, R.; Falk, R.; Volny, N.
1994. In: PTEC 94 Timber shaping the future: Proceedings of Pacific timber engineering conference; 1994 July 11–15; Gold Coast, Australia. Fortitude Valley MAC, Queensland, Australia: Timber Research Development and Advisory Council: 458–464. Vol. 2.

The focus of this research was to develop stress wave NDE techniques for determination of the in-place properties and strength of timber bridge components. Current inspection procedures for timber bridges is often an art involving visual assessments of the degree of decay and mechanical damage and of the extent to which the deterioration has penetrated into hidden regions of the structure.

79. The Role of Nondestructive Evaluation in Assuring the Wise Use of Our Timber Resource

Peterson, Kenneath R.
1994. In: Proceedings of 9th International symposium on nondestructive testing of wood; 1993 September 22–24; Madison, WI. Madison, WI: Forest Products Society: 7–9.

This paper reviews the historical development of nondestructive evaluation and shares the vision of the Forest Products Laboratory for using nondestructive evaluation in the future of forest resource management.

80. Kiln Drying Lumber in the United States—A Survey of Volume, Species, Kiln Capacity, Equipment, and Procedures, 1992–1993

Rice, Robert W.; Howe, Jeffrey L.; Boone, R. Sidney; Tschernitz, John L.1994. USDA Forest Serv. Gen. Tech. Rep. FPL–GTR–81. 24 p.

81. A Survey of Firms Kiln-Drying Lumber in the United States: Volume, Species, Kiln Capacity, Equipment, and Procedures

Rice, R.W.; Howe, Jeffrey L.; Boone, R. Sidney; Tschernitz, J.L.
1994. Forest Prod. J. 44(7/8): 55–62.

The purpose of this study (#80 and #81) was to assess the drying practices of the major primary and secondary lumber processors or manufacturers in the United States. Specifically, the following objectives were estab-

lished: (1) Determine the approximate volume and species of lumber kiln dried by primary and secondary manufacturers producing more than 2 million board feet annually and having at least one dry kiln; (2) determine the kiln capacities and kiln types used by major primary and secondary manufacturers; (3) determine the moisture monitoring methods and the maximum drying temperature being used.

82. Non-Destructive Evaluation of Timber in the United States

Ross, R.J.; Pellerin, R.F.; Sato, M.
1993. In: Nagataki, S.; Nireki, T.; Tomosawa, F., eds. Durability of building materials and components. Vol. 2—Durability, repair, design: Proceedings of 6th International conference; 1993 October 26–29; Omiya, Japan. New York: E & FN Spon: 1229–1235.

During the past 30 years, forest products researchers and the forest products industry have developed and used nondestructive testing tools for a wide range of applications ranging from the grading of structural lumber to the in-place evaluation of the mechanical properties of individual members in wood structures. The USDA Forest Service, Forest Products Laboratory, published a report that reviews nondestructive testing techniques used with wood products. The purpose of this paper is to provide a brief overview of that report and research results published since its completion.

83. Stress Wave Nondestructive Evaluation of Wetwood

Ross, Robert J.; Ward, James C.; TenWolde, Anton
1994. Forest Prod. J. 44(7/8): 79–83.

The objective of this study was to determine if measuring speed-of-sound transmission across the width of boards would be an effective technique to detect the presence of wetwood before kiln-drying red and white oak lumber.

Pulp, Paper, and Packaging

84. Fiber Fractionation as a Method of Improving Handsheet Properties After Repeated Recycling

Abubakr, Said; Scott, Gary; Klungness, John
1994. In: Proceedings of the 1994 TAPPI Recycling symposium; 1994 May 15–18; Boston, MA. Atlanta, GA: TAPPI Press: 309–312.

The objective of this secondary fiber research was to investigate the use of fiber fractionation to increase the utilization of office wastepaper by upgrading the quality of the fiber, thus minimizing the negative effects of recycling.

85. Raman Spectral Features Associated With Chromophores in High-Yield Pulps

Agarwal, Umesh P.; Atalla, Rajai H.
1994. J. Wood Chem. & Tech. 14(2): 227–241.

In this study, an unbleached thermomechanical pulp sample and additional thermomechanical pulp samples bleached by three different procedures were chosen for investigation by Raman spectral methods. The three bleached pulps differed with regard to the extent in which the chromophores were modified and/or removed when compared to the unbleached thermomechanical pulps.

86. An FT Raman Study of Residual Lignin in Kraft Pulps

Agarwal, U.P.; Weinstock, I.W.; Atalla, R.H.
1994. In: Yu, N.–T.; Li, X.–Y., eds. ICORS Hong Kong '94: Proceedings of 14 International conference on Raman spectroscopy; 1994 August 22–26; Hong Kong. New York: John Wiley Sons: 888–889.

Because of light absorption by residual lignin, previous attempts to analyze pulps using conventional Raman spectroscopy have not been successful. Strong laser-induced fluorescence contributions from pulp samples inhibited detection of Raman spectral features. However, this paper shows how with the development of the near-IR FT technique in Raman spectroscopy, the problem of fluorescence has been greatly reduced or eliminated for most samples.

87. Biomechanical Pulping of Aspen Wood Chips With Three Strains of *Ceriporiops subvermisoira*

Akhtar, Masood
1994. Holzforschung. 48(3): 199–202.

Different strains of *Ceriporiopsis subvermispora* differ in their biopulping performance on loblolly pine chips. Therefore, in the present investigation, an attempt was made to evaluate three strains of *Ceriporiopsis subvermispora* for its biopulping performance on aspen wood chips.

88. Biodegradation of Compression Wood and Tension Wood by White and Brown Rot Fungi

Blanchette, Robert A.; Obst, John R.; Timell, Tore E.
1994. Holzforschung. 48(Suppl.): 34–42.

This study was done to provide a comprehensive evaluation of wood degradation in compression and tension wood by several different types of white- and brown-rot fungi. Micromorphological and chemical analyses are provided to document changes that occur when compression wood and tension wood are degraded.

89. Reduction of Resin Content in Wood Chips During Experimental Biological Pulping Processes

Fischer, Kurt; Akhtar, Massood; Blanchette, Robert A.; Burnes, Todd A.; Messner, Kurt; Kirk, T. Kent
1994. Holzforschung. 48(4): 285–290.

This research examined the ability of two biopulping fungi, *Ceriporiopsis subvermispora* and *Phanerochaete chrysosporium*, to lower the resin content of wood chips and the ability of a commercial depitching fungus, *Ophiostoma piliferum*, to biopulp.

90. Recycling and Long-Range Timber Outlook—Background Research Report 1993 ARPA Assessment Update USDA Forest Service

Ince, Peter J.
1994. USDA Forest Service Res. Pap. FPL–RP–534. 110 p.

This report presents an economic analysis of the U.S. and Canadian pulp and paper sector and addresses the issue of paper recycling and its projected impact on the long-range timber outlook. The report describes the structure, data, and assumptions of a comprehensive economic model developed to simulate competitive future evolution of technology and markets for all products and fiber inputs of the U.S. and Canadian pulp and paper sector.

91. Impacts of Recycling Technology on North American Fiber Supply and Competitiveness

Ince, Peter J.; Zhang, Dali; Buongiomo
1994. In: What is determining international competitiveness in the global pulp and paper industry? Proceedings of 3d International symposium; 1994 September 13–14; Seattle, WA. Seattle, WA: Center for International Trade in Forest Products: 132–145.

This paper discusses results of studies that have involved modeling and projecting evolution of process technology, regional markets, and trade in the North American pulp and paper sector.

92. Fiber-Loading: A Progress Report

Klungness John, Caulfield, Daniel; Sachs, Irving; Tan, Freya; Sykes, Marguerite; Shilts, Richard
1994. In: Proceedings of the 1994 TAPPi Recycling symposium; 1994 May 15–18; Boston, MA. Atlanta, GA: TAPPI Press: 283–290.

In this study, it was investigated whether complete conversion of the reactants had occurred (using x-ray diffraction), where the calcium carbonate was deposited (scanning electron microscopy analysis), and how the properties of handsheets prepared from fiber-loaded pulps compared to

those made from direct-loaded pulps (conventional method of adding filler in the doler tank or papermachine chest).

93. Emerging Technologies for Reuse of Lignocellulosic Materials—Recycling Our Disposed Wood and Paper

Laufenberg, Theodore L.
1994. MRS Bull. 19(2): 13–14.

This issue explores some intricacies surrounding the recovery and reuse of biomaterials. Discussed are the critical issues facing the paper recycling community and the technologies being applied to this resource to create marketable materials.

94. Expanding Research Horizons: USDA Forest Service Initiative for Developing Recycled Paper Technology

Laufenberg, Theodore L.; Abubakr, Said
1994. In: What is determining international competitiveness in the global pulp and paper industry? Proceedings of 3d International symposium; 1994 September 13–14; Seattle, WA. Seattle, WA: Center for International Trade in Forest Products: 197–201.

This paper focuses on pulp and paper recycling technologies. Several studies are addressing technical challenges: (1) lack of adequate process technologies for cleaning, deinking, and screening; (2) need for innovative product concepts that increase the use of postconsumer wastes; and (3) altered strength and appearance characteristics of products made from recycled fiber compared to those made from virgin fiber.

95. Source Reduction Strategies and Technological Change Affecting Demand for Pulp and Paper in North America

Marcin, Thomas C.; Durbak, Irene A.; Ince, Peter J.
1994. In: What is determining international competitiveness in the global pulp and paper industry? Proceedings of 3d International symposium; 1994 September 13–14; Seattle, WA. Seattle, WA: Center for International Trade in Forest Products: 146–164.

This report (1) reviews basic definitions and measures of source reduction strategies, (2) examines consumption of various grades of paper and paperboard on a per capita basis, (3) estimates potential reductions of paper and paperboard demand for various source reduction strategies, (4) describes alternative technologies related to paper use, and (5) presents projections of long-term consumption of paper and paperboard.

96. On the Behavior of Monolignol Glucosides in Lignin Biosynthesis—II. Synthesis of Monolignol Glucosides Labeled With ^{3}H at the Hydroxymethyl Group of Side Chain, and Incorporation of the Label into Magnolia and Ginkgo Lignin

Matsui, Naoyuki; Fukushima, Kazuhiko; Yasuda, Seiichi; Terashima, Noritsugu
1994. Holzforschung. 48(5): 375–380.

This is a report about how interconversion of aromatic ring moiety occurs in the stage of cinnamyl alcohols or their glucosides in the pathway of lignin biosynthesis.

97. Preliminary Results of Effect of Sizings on Enzyme-Enhanced Deinking

Rutledge–Cropsey, Kathie; Klungness, John H.; Jeffries, Thomas; Sykes, Marguerite
1994. In: Proceedings of the 1994 TAPPI Recycling symposium; ;1994 May 15–18; Boston, MA. Atlanta, GA: TAPPI Press: 103–105.

This report presents results of preliminary research on whether enzymatic deinking is affected by the physical presence of acid and alkaline sizings or the hydrophobic nature of sized fibers.

98. Spaceboard II Panels: Preliminary Evaluation of Mechanical Properties

Scott, C.; Laufenberg, T.
1994. In: PTEC 94 Timber shaping the future: Proceedings of Pacific timber engineering conference; 1994 July 11–15; Gold Coast, Australia. Fortitude Valley MAC, Queensland, Australia: Timber Research and Development Advisory Council: 632–638. Vol. 2.

The objective of this study was to characterize, under dry conditions, the basic mechanical properties of Spaceboard II. These evaluations will provide the basis for determining the potential of Spaceboard II as a structural-use panel. A variety of standard tests were conducted to measure various panel properties: bending stiffness and strength, concentrated load application, bearing strength, and interlaminar shear. In addition, coupons were extracted from specific facing locations to measure tensile and compression properties.

99. Evaluation of Long Soaking Times for Rehydration of Recycled Fibers

Scott, Gary M.; Abubakr, Said
1994. In: Proceedings of the 1994 TAPPI Recycling symposium; 1994 May 15–18; Boston, MA. Atlanta, GA: TAPPI Press: 127–130.

This study investigated the effect of extended soaking times of up to 8 h to determine if longer contact with water will improve the hydration of the fiber before disintegtration. Chemical addition was also investigated.

100. Fractionation of Secondary Fiber—A Review

Scott, Gary M.; Abubakr, Said
1994. Progress in Paper Recycling. 3(3): 50–59.

This paper is a review of the current literature on fiber fractionation. The processing equipment available for fiber fractionation is discussed along with the grades of recovered paper that are considered candidates for fractionation. This paper also discusses the characterization of the fractions, modeling of the fractionation, and other recycling operations.

101. Delignification of Aspen Wood With Pernitric Acid

Springer, Edward L.
1994. Tappi J. 77(6): 103–108.

This study evaluated the feasibility of delignifying aspen wood with pernitric acid. Treating finely divided aspen wood with dilute aqueous pernitric acid and extracting it with dilute alkali readily delignifies the wood. Pernitric acid consumption is excessive due to its rapid self-decomposition. Mixing concentrated hydrogen peroxide with concentrated nitric acid easily produces pernitric acid. Such mixtures present a serious explosion hazard requiring extreme care in their preparation and use.

102. Deinking Flexographic Newsprint: Ultrafiltration Technology as a Method for Wash Filtrate Clarification

Upton, Bradley H.; Krishnagopalan, Gpopal A.; Abubakr, Said
1994. In: Proceedings of the 1994 TAPPI Recycling symposium; 1994 May 15–18; Boston, MA. Alanta, GA: TAPPI Press: 17–24.

This study focuses on the feasibility of membrane separation techniques to remove dispersed water-based pigments from aqueous dispersions.

103. Expanding Research Horizons: USDA Forest Service Initiative for Recycled Paper Technology Development

Wegner, Theodore H.; Laufenberg, Theodore L.
1994. In: Proceedings of the 1994 TAPPI Recycling symposium; 1994 May 15–18; Boston, MA. Atlanta, GA: TAPPI Press: 225–228.

This report describes studies on pulp and paper recycling in five problem areas: paper and fiber sorting technologies, deinking and contaminant removal, pulp bleaching technologies, restoration of papermaking properties of recycled fibers, and performance characteristics of recycled paper.

Tropical Wood Utilization

104. The Importance of Nutrient Pulses in Tropical Forests

Lodge, D.J.; McDowell, W.H.; McSwiney, C.P.
1994. TREE. 9(10): 384–387.

This paper discusses recent research showing that nutrient fluxes are often pulsed in tropical forests, and that pulsed versus gradual inputs have different effects on the fates of nutrients in the ecosystem.

105. Sawing Hardwoods in Five Tropical Countries

Loehnertz, Stephen P.; Cooz, Iris Vazquez; Guerrero, Jorge.
1994. USDA Res. Note FPL–RN–0262. 11 p.

In this study, hardwood sawing technology was identified in five tropical countries: Ghana, Brazil, Venezuela, Indonesia, and Malaysia. The most commonly reported problems include poor saw maintenance, lack of trained personnel, obsolete equipment, and inadequate sawtooth geometry and wear resistance. Some problems can be addressed by technology transfer, others must be addressed by research.

Wood Bonding Systems

106. Carbohydrate Polymers as Adhesives

Baumann, Melissa G.D.; Conner, Anthony H.
1994. In: Pizzi, A.; Mittal, K.L., eds. Handbook of adhesive technology. New York: Marcel Dekker, Inc. Chap. 15.

Three major carbohydrate polymers are readily obtained from biomass and are commercially available. These polysaccharides are celluose, starch, and gums. The use of each of these types of carbohydrate polymers for adhesives is discussed in this chapter.

107. Effect of Overdrying of Yellow-Poplar Veneer on Physical Properties and Bonding

Christiansen, A.W.
1994. Holz als Roh– und Werkstoff. 52: 139–149.

The intent of this study was to follow the changes of various physical properties as the wood was overdried at high temperature and determine if these changes correlated with the ability of the wood to bond with phenolic resins.

108. Behavior of Amine-Modified Urea-Formaldehyde-Bonded Wood Joints at Low Formaldehyde/Urea Molar Ratios

Ebewele, Robert O.; River, Bryan H.; Myers, George C.
1994. J. Appl. Poly. Sci. 52: 689–700.

The objective of the present study was to investigate the effectiveness of modifying urea-formaldehyde resins with selected flexible amines at formaldehyde/urea ratios of 1.4 and 1.2. As in previous work, the effectiveness in terms of the resistance to cyclic soak-dry and moist-heat aging and in terms of the formaldehyde emission of bonded wood products was evaluated.

109. Fracture of Adhesive-Bonded Wood Joints

River, Bryan H.
1994. In: Pizzi, A.; Mittal, K.L., eds. Handbook of adhesive technology. New York: Marcel Dekker, Inc. Chap. 9.

This chapter briefly examines the current understanding of fracture mechanisms in wood-adhesive joints. The discussion is limited to joints bonded with those adhesives having sufficient strength and rigidity to cause fracture in the wood adherends. Primarily, these are the rigid, thermosetting poly(vinyl acetate) adhesives and some thermoplastic types such as poly(vinyl acetate).

110. Failure Mechanisms in Wood Joints Bonded With Urea-Formaldehyde Adhesives

River, B.H.; Ebewele, R.O.; Myers, G.D.
1994. Holz als Roh–und Werkstoff. 52: 179–184.

The purpose of this study was to develop an understanding of the failure mechanisms of wood joints bonded with unmodified and amine-modified urea-formaldehyde adhesives, thereby learning how such modification improves the durability of urea-formaldehyde-bonded joints.

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